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BEHAVIOR OF SOME POTATO VARIETIES UNDER THE INFLUENCE OF THE THERMO-HYDRIC STRESS FACTORS SPECIFIC TO THE SANDY SOILS AREA

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ABSTRACT

During the vegetation period, was analyzed the diurnal and seasonal variation of the physiological processes (the rate of photosynthesis and foliar transpiration) at 4 varieties and 2 lines of potato grown on sandy soils. The rate of photosynthesis showed a diurnal variation, being influenced by the active radiation in photosynthesis and air and soil humidity, as well as by the studied varieties and lines. In the tuber growth phase, the average of photosynthesis oscillated between 12,49 µmol $CO^2/m^2/s$ at the Castrum variety and 21,03 µmol $CO^2/m^2/s$ at the L 15-1677/31. At this stage of vegetation, the L 15 line was net detached of the other varieties, having a maximum photosynthesis which has positively influenced the production of tubers, recorded at 45 days after the emergence of plants (42,4 tons/ha). The high air temperature of 37,3 °C and the relative air humidity below 30% increased the evaporation of water through foliar transpiration at all varieties and lines studied. High values at the transpiration rate were recorded at 12-15 o'clock, when the action of stress factors was maximal, at the Sarmis variety (8,35 mmol $H_2O/m^2/s$), and at line L 15-1677/31 (8,74 mmol $H_2O/m^2/s$).

INTRODUCTION

Researches on the behavior of potato varieties and the influence of agro-technical factors (irrigation and fertilization) were performed in other potato culture areas by researchers: Chichea and Săninoiu (1994), Berindei and Chichea (1997), Draica (1995). Research by Carpentieri 1990 showed that photosynthetic activity remained stable up to 30 ^oC then decreased and inhibited to 40 ^oC. Research on Hammes potato in 1990 showed that raising the temperature from 15 ^oC to 40 ^oC resulted in a decrease in the net intensity of the photosynthesis process by 37 % compared to that determined at 20 ^oC. Under conditions of thermal stress the photosynthesis process is inhibited by decrease in Ribuloso-diphosphate-carboxylase enzyme activity after Sage and Cubien in 2007. Drought determines the concentration of the soil solution, reduces foliar absorption by accumulation of abscisic acid that closes stomata and increases 100 times in water stress (Salisbury and Ross-1991). Active photosynthetic radiation plays a role in the induction of photosynthesis as well as foliar transpiration, by the photoactive actions of opening the stomata and by increasing the temperature of the leaves (Burzo I. 2004). Atmospheric and pedological drought limits the metabolism of plants that enter into thermo-hydric stress (Petcu Elena 2008).

MATERIALS AND METHODS

During the vegetation period of 2017 year, were studied 4 varieties and 2 potato lines , with determinations carried out on vegetation phases and in 3 moments during the day, regarding:

- the active radiation in photosynthesis;
- the rate of photosynthesis;
- air temperature at leaves level;
- the foliar transpiration rate.

All this determinations where made with the LC PRO + portable device.

RESEARCH RESULTS

During the vegetation period at 45 days after the emergence of potato plants (Table 1) PAR (Photosynthetic Active Radiation) was oscillating at 9 o'clock between 1315 and 1328 µmol/m^2/s, at 12 o'clock between 1823 and 1860 µmol/m^2/s and between 1454-1864 µmol/m^2/s at 15 o' clock. The L14, L15 lines and Castrum variety recorded peak values of the active radiation in photosynthesis at the time of the determinations.

The rate of photosynthesis (Table 1) was influenced by the high air temperature of 37,2 °C and low atmospheric humidity to 30 %.

The rate of photosynthesis showed a diurnal variation under the influence of climatic factors in the area.

Photosynthesis rate values oscillated at 7 o'clock between 7,30 µmol CO_2/m^2/s at Castrum variety and 23,82 µmol CO_2/m^2/s at L 15-1677/31 line; at 12 o'clock between 15,07 µmol CO_2/m^2/s at Marvis variety and 28,02 µmol CO_2/m^2/s at the Braşovia variety, and at 15 o'clock between 7,37 µmol CO_2/m^2/s at Marvis variety and 18,09 µmol CO_2/m^2/s at the Sarmis variety.

The Braşovia variety and the L15 line recorded maximum values at the rate of photosynthesis at this stage of vegetation. The daily average values oscillated between 12,49 µmol CO_2/m^2/s at the Castrum variety and 21,03 µmol CO_2/m^2/s at line L 15 - 1677/31. The L15 line showed maximum value at the rate of photosynthesis, being double compared to the Marvis and Castrum varieties.

Table 1

Diurnal variation of photosynthesis rate at potato varieties at 45 days after the emergence

Variety	PAR µmol/m^2/s	Photosynthesis rate µmol CO_2/m^2/s	PAR µmol/m^2/s	Photosynthesis rate µmol CO_2/m^2/s	PAR µmol/m^2/s	Photosynthesis rate µmol CO_2/m^2/s	Daily average of photosynthesis µmol CO_2/m^2/s
	9 o'clock		12 o'clock		15 o'clock		
Marvis	1325	19.49	1833	15.07	1454	7.37	13.97
Braşovia	1317	20.69	1823	28.02	1500	13.35	20.68
Castrum	1315	7.30	1860	21.77	1797	8.42	12.49
Sarmis	1312	19.40	1830	22.55	1600	18.09	20.01
L 14-1574/4	1322	17.84	1833	18.26	1864	9.56	15.22
L 15-1677/31	1328	23.82	1840	20.98	1506	18.31	21.03

The foliar transpiration rate (Table 2) was influenced by climatic factors (air temperature, air and soil humidity) and varieties and lines studied. The daily variation in foliar transpiration rate recorded the following values:

- at 9 o'clock the values varied between 4,99 mmol H_2O/m^2/s at Castrum variety and 2,64 mmol H_2O/m^2/s at line L15-1677/31;
- at 12 o'clock the values of the transpiration rate oscillated between 8,40 mmol H_2O/m^2/s at the Sarmis variety and 10,14 mmol H_2O/m^2/s at line L 15-1677/31;
- at 15 o'clock values fluctuated between 4,56 mmol H_2O/m^2/s at the Marvis variety and 10,72 H_2O/m^2/s at line L 15-1677/31.

Line L 15-1677/31 recorded maximum values at the foliar transpiration rate at all times of the determinations and made very good use of the evaporated water by foliar transpiration because the recorded photosynthesis was maximum under the same climatic conditions. The daily average value recorded a minimum of 6,08 mmol H_2O/m^2/s in the Marvis variety and a maximum of 8,85 H_2O/m^2/s at line L 15-1677/31.

In this vegetation phase, the L15 line is net detached of the other varieties, having maximum photosynthesis which positively influenced the tubers production at 45 days after emergence and recorded 42,42 tons / ha.

Table 2

Diurnal variation of leaf transpiration rate at potato varieties at 45 days after the emergence

Variety	Air temperature at leaves level (^oC)	Transpiration rate mmoli $H_2O/m^2/s$	Air temperature at leaves level (^oC)	Transpiration rate mmoli $H_2O/m^2/s$	Air temperature at leaves level (^oC)	Transpiration rate mmoli $H_2O/m^2/s$	Daily average of leaf transpiration
	9 o'clock		12 o'clock		15 o'clock		
Marvis	30.9	5.00	36.0	8.69	37.2	4.56	**6.08**
Braşovia	31.0	5.12	34.9	9.15	36.7	9.22	**7.83**
Castrum	30.7	5.40	35.0	9.01	37.8	7.83	**7.41**
Sarmis	29.6	4.99	34.5	8.40	37.6	8.79	**7.39**
L 14-1574/4	31.5	5.34	36.6	8.97	37.2	6.66	**6.99**
L 15-1677/31	31,8	5.69	36.6	10.14	37.3	10.72	**8.85**

Figure 1 shows the variation of photosynthesis and foliar transpiration rate in relation to air temperature and studied varieties. Under the same climatic conditions, the Braşovia, Sarmis and L 15-1677/31 varieties showed higher values at the rate of photosynthesis. The foliar transpiration rate is more influenced by the air temperature, of 34 – 35 °C.

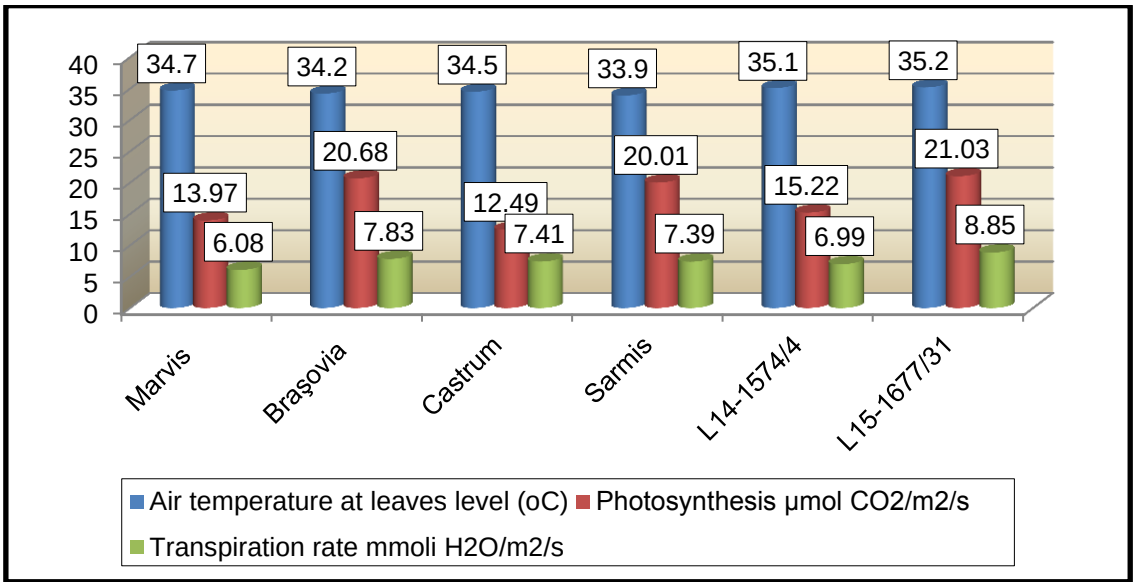

Fig.1 Daily average of photosynthesis and foliar transpiration depending on temperature and variety at 45 days after the emergence

Tuber production at the first harvest ranged between 13,56 tonnes/ha at the Castrum variety and 44,34 tonnes/ha on line L15-1677/31.

Figure 2 shows the translocation of assimilates, which occurred either to vegetative growth or to tuber production. At the two lines the assimilates are found in tuber production, compared to Castrum where the assimilates are directed to vegetative growths, at the expense of production.

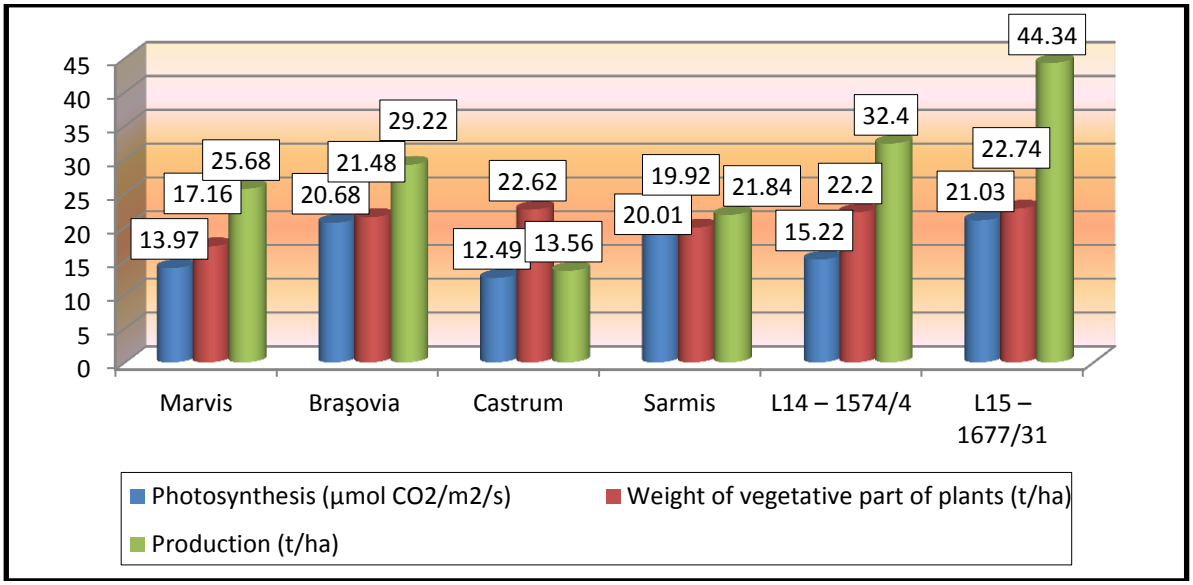

Fig. 2 Translocation of assimilates into the vegetativ growths and tubers at 45 days after emergence

In the intensive growth phase of the tubers at 55 days from emergence (Table 3) PAR oscillated between 1240 µmol/m^2/s at Marvis variety and 1263 µmol/m^2/s at Castrum variety at 9 o'clock, between 1570 µmol/m^2/s at Sarmis variety and 1704 µmol/m^2/s at the Brasovia variety at 12 o'clock and between 1290 µmol/m^2/s at the Marvis variety and 1770 µmol/m^2/s at the Sarmis variety at 15 o'clock.

The photosynthesis rate values oscillated:

- at 9 am, between 13,61 µmol CO_2/m^2/s at Marvis variety and 27,04 µmol CO_2/m^2/s at line L 15-1677/31.

- at 12 o'clock between 6,39 µmol CO_2/m^2/s at line L 14-1574/4 and 17,01 µmol CO_2/m^2/s at the Sarmis variety.

- at 15 o'clock between 1,15 µmol CO_2/m^2/s at line L 14-1574/4 and 18,38 µmol CO_2/m^2/s at L 15-1677/31.

The average daily value oscillated between 7,71 µmol CO_2/m^2/s at L 14-1574/4 and 20,61 µmol CO_2/m^2/s at L 15-1677/31.

In this phase of vegetation the Sarmis variety and line L 15-1677/31 recorded high values at the rate of photosynthesis compared to other varieties.

Table 3

Diurnal variation of photosynthesis rate at potato varieties at 55 days after the emergence (12.06.2017)

Variety	PAR µmol/m^2/s	Photosynthesis rate µmol CO_2/m^2/s	PAR µmol/m^2/s	Photosynthesis rate µmol CO_2/m^2/s	PAR µmol/m^2/s	Photosynthesis rate µmol CO_2/m^2/s	Daily average of photosynthesis
	9 o'clock		12 o'clock		15 o'clock		
Marvis	1240	13.61	1689	8.95	1290	4.01	**8.85**
Braşovia	1261	16.86	1704	7.26	1779	3.20	**9.10**
Castrum	1263	22.70	1648	15.86	1779	9.15	**15.90**
Sarmis	1253	15.30	1570	17.01	1884	12.13	**14.81**
L 14-1574/4	1245	15.59	1683	6.39	1358	1.15	**7.71**
L 15-1677/31	1255	27.04	1658	16.43	1740	18.38	**20.61**

In the intense growth phase of the tubers, the air temperature oscillated between 30 and 37,3 °C, influencing the loss of water by evaporation at the leaves level.

The diurnal variation of leaf transpiration rate (Table 4) recorded the following values:

- at 9 o'clock values ranged between 3,07 mmol $H_2O/m^2/s$ at the Marvis variety and 5,11 mmol $H_2O/m^2/s$ at Castrum variety;
- at 12 o'clock the values of the transpiration rate oscillated between 4,43 mmol $H_2O/m^2/s$ at Brasovia and 8,35 mmol $H_2O/m^2/s$ at the Sarmis variety;
- at 15 o'clock values fluctuated between 2,06 mmol $H_2O/m^2/s$ at line L14 and 8,74 mmol $H_2O/m^2/s$ at line L15-1677/31.

The maximum transpiration rate was recorded at 12-15 o'clock, at the Sarmis variety and at line L 15-1677/31, and the minimum was recorded at 9 o'clock at L 14 - 1574/4.

The daily average value recorded a minimum of 3,37 mmol $H_2O/m^2/s$ at L14-1574/4 and a maximum of 6,64 mmol $H_2O/m^2/s$ at L15-1677/31.

The high air temperature of 37,3 °C and the air humidity below 30 % increased the evaporation of water through foliar transpiration in all varieties and lines studied. The L 15-1677/31 line efficiently used evaporated water, recording high values at the rate of photosynthesis.

Table 4

Diurnal variation of leaf transpiration rate at potato varieties at 55 days after the emergence

Variety	Air temperature at leaves level (°C)	Transpiration rate mmoli $H_2O/m^2/s$	Air temperature at leaves level (°C)	Transpiration rate mmoli $H_2O/m^2/s$	Air temperature at leaves level (°C)	Transpiration rate mmoli $H_2O/m^2/s$	Daily average of leaf transpiration
	9 o'clock		12 o'clock		15 o'clock		
Marvis	30.2	3.07	35.6	7.02	36.4	3.74	**4.61**
Braşovia	30.4	4.31	37.0	4.43	35.5	2.30	**3.68**
Castrum	30.4	5.11	37.2	6.80	36.1	4.12	**5.34**
Sarmis	30.0	3.68	36.7	8.35	36.5	6.63	**6.28**
L 14-1574/4	30.7	3.32	35.3	4.75	37.3	2.06	**3.37**
L 15-1677/31	30.8	4.98	35.0	6.21	37.3	8.74	**6.64**

Analyzing the results obtained at 55 days after the emergence, it was observed that at a relatively constant and quite high average temperature, the photosynthesis values oscillated quite a lot, depending on the variety, detaching the Sarmis, Castrum and L 15-1677/31. Lower values recorded the Marvis, Brasovia and L14-1574/4 varieties, which demonstrate the influence of the variety on physiological processes.

Tuber production at second harvest oscillated between 20,94 tonnes/ha at Marvis variety and 45,62 tonnes/ha at line L15-1677/31 (Table 5).

Table 5

Photosynthetic yield at second harvest (55 days after the emergence)

Variety	Photosynthesis (µmol $CO_2/m^2/s$)	Weight of vegetative part of plants (t/ha)	Tuber production (t/ha)
Marvis	8,85	7.50	20.94
Braşovia	9,10	13.44	34.02
Castrum	15,90	21.72	34.62
Sarmis	14,81	16.20	37.74
L14 – 1574/4	7,71	14.16	37.32
L15 – 1677/31	20,61	14.88	45.62

CONCLUSIONS

Climatic factors during the vegetation period (air temperature above 35 °C, air humidity below 30 %) influenced the speed and pace of the physiological processes under study.

The rate of photosynthesis showed a diurnal variation, being influenced by the active radiation in photosynthesis and air and soil humidity, as well as by the studied varieties and lines.

In the tuber growth phase at 45 days after emergence, the mean daily value oscillated between 12,49 µmol $CO_2/m^2/s$ at the Castrum variety and 21,03 µmol $CO_2/m^2/s$ at line L 15 – 1677/31. The L15 line showed maximum value at the rate of photosynthesis, being double compared to the Marvis and Castrum varieties. In this vegetation phase, the L15 line is net detached of the other varieties, having maximum photosynthesis which positively influenced the tubers production at 45 days after emergence and recorded 42,42 tons/ha.

Line L 15-1677/31 recorded maximum values at the foliar transpiration rate at all times of the determinations and very efficiently used the evaporated water through foliar transpiration because the recorded photosynthesis was maximum under the same climatic conditions.

High values at the transpiration rate were recorded at 12-15 pm, when the action of stress factors was maximal, at the Sarmis variety (8,35 mmol $H_2O/m^2/s$) and at line L 15-1677/31 (8,74 mmol $H_2O/m^2/s$)

Drought-resistant and high-yielding potato lines will be expanded into crops on sandy soils.

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